TITLE OF THE INVENTION

TIRE PRESSURE HOLDING SYSTEM, TIRED WHEEL AND VALVE UNIT FOR USE WITH VEHICLE AND TIRE

BACKGROUND OF THE INVENTION

1. Field of the invention

This invention relates to a vehicle provided with pneumatic tires, such as bicycles, motorbikes, motorcycles, automobiles and air-planes, a tire pressure holding system which can be provided in the vehicle, a tired wheel and a valve unit suitable for use with a tire.

2. Description of the related art

There has conventionally been provided a bicycle with an integral bicycle pump. For example, JP-A-2000-335471 discloses such a bicycle. The disclosed bicycle is illustrated in FIG. 16 of the present application. As shown in FIG. 16, a packing 3 is attached to a lower end of a support 2 of a saddle 1. The support 2 is inserted in a pipe 4 of a bicycle frame so that the packing 3 is slidable in the pipe. A hose 5 connected to a lower end of the pipe 4 is further connected to a tire valve (not shown). Compressed air is supplied into a tire when the support 2 is moved up and down with the saddle 1.

However, the above-described construction cannot eliminate a work of supplying air into the tire. Accordingly, a frequent work of supplying air into the tire is required so that an internal pressure of the tire is maintained at a suitable value. Furthermore, the tire can be excessively deformed when a user

or rider is unaware of a reduction in the internal pressure of the tire.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide a tire pressure holding system which can automatically supply compressed air into the tire, a tired wheel provided with such a system and a valve unit suitable for use in such a system.

The present invention provides a tire pressure holding system for a vehicle having at least a wheel and a tire mounted around the wheel, the tire having an interior. The system comprises a pump provided in a center of the wheel for discharging compressed air in synchronization with revolution of the wheel, the pump including a discharge section from which the compressed air is discharged, a conduit connected to the tire and the discharge section of the pump, a check valve provided in the conduit for preventing the air in the interior of the tire from flowing to the pump side, and a release valve provided in the conduit for releasing the compressed air from the pump outside when an internal pressure is at or above a predetermined value in a section of the interior of the conduit between the check valve and the pump.

When the vehicle is run, the pump is driven in synchronization with revolution of the wheel to supply the compressed air into the conduit. In this case, when an internal pressure of the tire is lower than a normal pressure, the check valve is opened due to the difference between an internal pressure of the conduit and the internal pressure of the tire, whereby the compressed

air is supplied into the tire. The check valve is closed when the difference between the internal pressures of the conduit and the tire is rendered smaller upon completion of compressed air supply into the tire. Furthermore, when the internal pressure of the conduit is increased to a value equal to or larger than a predetermined value, the release valve is opened to release the compressed air from the pump to the outside. Thus, the compressed air can automatically be supplied into the tire. Moreover, compressed air, when excessively supplied, is released outside, whereupon the internal pressure of the tire can be stabilized.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of the invention will become clear upon reviewing the following description of embodiments, made with reference to the accompanying drawings, in which:

FIG. 1 is a side view of a bicycle in accordance with one embodiment of the present invention;

FIG. 2 is a sectional side view of a tire pressure holding system provided on the bicycle;

FIG. 3 is a sectional side view of a valve unit with a release valve thereof being closed;

FIG. 4 is a sectional side view of the valve unit with the release valve being opened;

FIG. 5 is a sectional side view of a valve core in the open state;

FIG. 6 is a sectional side view of the valve core in the closed state;

FIG. 7 is a sectional side view of the valve unit in accordance with a second embodiment of the invention with the release valve being closed;

FIG. 8 is a sectional side view of the valve unit with the release valve being opened;

FIG. 9 is a sectional side view of the valve unit in accordance with a third embodiment of the invention;

FIG. 10 is a sectional side view of the valve unit in accordance with a fourth embodiment of the invention;

FIG. 11 is a sectional side view of the valve unit in accordance with a fifth embodiment of the invention;

FIG. 12 is a sectional side view of the tire pressure holding system in accordance with a sixth embodiment of the invention;

FIG. 13 is a sectional side view of a pump in accordance with a seventh embodiment of the invention;

FIG. 14 is a sectional side view of the pump in another operating state;

FIG. 15 is a sectional front view of the pump; and

FIG. 16 is a sectional view of a pump provided on a conventional bicycle.

DETAILED DESCRIPTION OF THE INVENTION

A first embodiment of the present invention will be described with reference to FIGS. 1 to 6. Referring to FIG. 1, a bicycle 10 is shown as a vehicle in accordance with the present invention.

The bicycle 10 includes front and rear wheels 11 each of which includes a centrally disposed pump 12 in accordance with the invention. Each wheel 11 further includes a plurality of hub spokes 15 secured to an outer periphery of the pump 12 and a reel 14 with which a tire 13 is fitted.

Referring to FIG. 2, an inner structure of the pump 12 is shown. The pump 12 produces compressed air by a coherent mechanism 20. More specifically, the pump 12 includes a rotary block 21 formed into a generally cylindrical shape and having opposite ends including a bottom. A cylindrical inner housing 24 is enclosed in the rotary block 21. The inner housing 24 is rotatably mounted on a shaft further mounted on both end walls 21T of the rotary block 21 so as to be in contact with a part of the inner circumferential face of the rotary block 21. The rotary block 21 has an axial center located inside the inner housing 24. An axle 22 of the bicycle 10 extends along the axial center of the rotary block 21 through the latter. The axle 22 has both ends secured to a body of the bicycle 10 so as to be unrotatable. When the bicycle 10 is run, the rotary block 21 is rotated about the axle 22.

A partition projection 23 is fixed to the axle 22. The projection 23 extends through a slit 24S formed in the circumferential face of the inner housing 24, abutting the inner circumferential face of the rotary block 21. Upon revolution of the wheel 11, the projection 23 is turned in the rotary block 21. The inner housing 24 is rotated in the rotary block 21 with turn of the projection 23. As a result, a space defined between the rotary block 21 and the inner housing 24 is divided by the

projection 23 into two chambers 12K. The capacity of each chamber 12K is increased or decreased in synchronization with revolution of the wheel 11.

The rotary block 21 has a circumferential wall 21E formed with an inlet 25 and an outlet section 26 between which the contact portion of the rotary block 21 with the inner housing 24 is disposed. When the wheel 11 is revolved counterclockwise as viewed in FIG. 2, air introduced through the inlet 25 into the chamber 12K is converted into compressed air, which is discharged through the outlet section 26. The outlet section 26 is provided with a cylindrical wall 27 projecting from the circumferential wall 21E. A pipe joint 28 is screwed into a distal end of the cylindrical wall 27. A pipe 29 has one of two ends which is fixed to the pipe joint 28 as shown in FIG. 2. The other end of the pipe 29 extends to the reel 14 side of the wheel 11 to be fixed to a tire valve unit 30. The outlet section 26 of the pump 12, the valve unit 30 and the pipe 29 constitute a tire pressure holding system in accordance with the present invention.

Referring to FIG. 3, the valve unit 30 is shown in more detail. The valve unit 30 includes a shaft-like stem 32 extending through a through hole 14A formed in the reel 14. A tire tube 13C provided inside the tire 13 is fixed to a proximal end of the stem 32, whereupon a space 32A axially defined inside the stem 32 communicates with an inner space 13A of the tire 13 or more specifically, with an inner space of the tire tube 13C. More specifically, the stem 32 includes a base stem 33 fixed to the tire tube 13C and an extended stem 34 engaged with an outer face of the base stem 33. An annular disc 35 is also engaged with

the outer face of the base stem 33. An edge of the through hole 14A is held between the extended stem 34 and the disc 35, whereupon the stem 32 is fixed so as to stand from the reel 14 toward the pump 12.

The stem 32 further includes a valve core 40 and a release valve 65 disposed in turn in this order from the tire 13 side. The valve core 40 includes a flange-like rubber plug 62 fixed to one end of a shaft 61 extending through a cylindrical member 60 as shown in FIG. 5. The rubber plug 62 serves as a check valve lid in the present invention. When the shaft 61 is urged to one side by a coil spring 63 provided in the cylindrical member 60 so that the rubber plug 62 is normally pressed against one open end of the cylindrical member to close the valve core 40, as shown in FIG. 5. The coil spring 63 thus serves as check valve urging means in the invention. When the shaft 61 is moved against the coil spring 63, the rubber plug 62 is separated from the cylindrical member 60, whereby the valve core 40 is opened so that air is allowed to flow therethrough, as shown in FIG.6.

The release valve 66 has such an elongated shape as to be direct moved in the extended stem 34 and includes a flange 67 on an end at the side thereof spaced away from the valve core 40, as shown in FIG. 3. A surrounding wall 68 projects from an outer edge of the flange 67 toward the valve core 40. A disc-shaped sealing member 69 is provided inside the surrounding wall 68. On the other hand, the extended stem 34 has a stepped portion 34D formed on an inner face thereof. A circular projecting member 70 projects from an inner edge of the stepped portion 34D toward a direction in which the projecting member is departed from the

valve core 40. Furthermore, a coil spring 71 is disposed, in a compression-deformed state, between the flange 67 of the release valve 66 and a distal end wall 34S of the extended stem 34. The sealing member 69 of the release valve 66 is pressed against the circular projecting member 70 by the spring force of the coil spring 71.

The space 32A in the stem 32 includes a release chamber 32C separated from the valve core 40 as the result of close adherence of the sealing member 69 of the release valve 65 and the circular projecting member 70. The release chamber 32C includes a release hole 73 formed through a side wall of the extended stem 34 near the projecting member 70. The space 32A further includes a charge chamber 32B defined by the valve core 40 and a closely adhered portion between the sealing member 69 of the release valve 65 and the circular projecting member 70. The charge chamber 32B includes an air supply hole 72 formed through a side wall of the extended stem 34. A pipe 29 extending from the pump 12 has an end connected to the air supply hole 72. The outlet section 26 of the pump 12, the stem 32 and the pipe 29 constitute a conduit 74 in the invention, as shown in FIG. 2.

The release valve 65 has an end against which the shaft 61 of the valve core 60 is pressed. The release valve 65 and the shaft 61 are urged by the aforesaid coil springs 63 and 71 so that the valve and the shaft are pressed in opposite directions respectively. Accordingly, the release valve 65 and the shaft 61 are substantially connected to each other, whereupon the valve core 40 is operated in synchronization with release valve 65.

The operation of the bicycle 10 will now be described. The

pump 12 is inoperative when the bicycle 10 is stopped. In this case, the valve core 40 is closed and the release valve 65 is open in the valve unit 30. When the bicycle 10 is run, the pump 12 is driven in synchronization with revolution of the wheel 11. Consequently, compressed air is supplied into the charge chamber 32B of the valve unit 30. Part of the compressed air flows through the release valve 65, leaking from the release hole 73. However, when the bicycle 10 is run at or above a predetermined speed, an amount of compressed air supplied from the pump 12 becomes larger than an amount of compressed air leaking from the release hole 73, whereupon the internal pressure of the charge chamber 32B is increased. In this case, when the internal pressure of the tire 13 or the tire tube 13C is lower than that in the normal state of the tire, the valve core 40 is opened on the basis of a difference between the internal pressures of the charge chamber 32B and the tire 13. The release valve 65 is then closed in synchronization with the opening of the valve core 40, whereby the compressed air from the pump 12 is supplied into the tire 13. When the internal pressure of the tire 13 is increased as the result of supply of the compressed air, the valve core 40 is closed and the release valve 65 is opened in synchronization with the closure of the valve core, whereupon the compressed air from the pump 12 is released outside the valve unit 30.

According to the bicycle 10 of the embodiment, compressed air ca automatically be supplied into the tire 13 and accordingly, the internal pressure of the tire can be stabilized. Furthermore, the valve core 40 and the release valve 65 are linked with each other so that the release valve is held open while the valve core

is closed. Accordingly, since an excessive amount of compressed air from the pump 12 is smoothly released outside, a revolution resistance of the wheel 11 can be reduced. Additionally, the tire pressure holding system 31 of the embodiment is divided into the pump 12, the valve unit 30 and the pipe 29 connecting the pump and the valve unit. Consequently, the length of the pipe 29 can be changed so as to correspond to various sizes of wheels 11, and the pump 12 and the valve unit 30 can be used as common components for the various sizes of wheels 11.

Other embodiments of the invention will be described hereinafter. In the following description, only the difference from one or more previous embodiments will be described. Identical or similar parts in each of the following embodiments are labeled by the same reference symbols as those in the previous embodiments, and accordingly, the description of these parts will be eliminated.

FIGS. 7 and 8 illustrate a second embodiment of the invention. The valve unit 30V of the second embodiment differs from the valve unit of the first embodiment in the construction of the release valve 65V. The release valve 65 provided in the valve unit 30V of the second embodiment has a smaller axial length than the release valve 65 in the first embodiment, so as not to be brought into contact with the shaft 61 of the valve core 40. Furthermore, the sealing member 69V is made of a rubber tube with a circular section into such an annular shape that the sealing member is fitted in the inside of the surrounding wall 68. The other construction of the valve unit 30V is the same as that of the valve unit 30 in the first embodiment.

In operation of the valve unit 30, both of the valve core 40 and the release valve 65 are closed when the pump 12 is inoperative due to stop of the bicycle 10, as shown in FIG. 7. Upon run of the bicycle 10, the pump 12 is driven so that the charge chamber 32B is charged with compressed air. In this case, when the internal pressure of the tire 13 is lower than the normal internal pressure, the valve core 40 is opened due to the difference between the internal pressures of the charge chamber 32B and the tire 13 to supply compressed air into the tire 13. The valve core 40 is closed when the internal pressure of the tire 13 is increased to the normal internal pressure. In this state, when the compressed air from the pump 12 increases the internal pressure of the charge chamber 32B, the release valve 65 is opened to release an excessive amount of compressed air outside the valve unit 30V. See FIG. 8.

FIG. 9 illustrates a valve unit 30W in a third embodiment of the invention. The third embodiment is a modified form of the second embodiment. An intermediate valve 80 is provided between the release valve 65 of the stem 32 and the valve core 40. The intermediate valve 80 includes a shaft 81 direct moved in the passage 74, a disc-like sealing member 82 and a limiting plate 83. The sealing member 82 and the limiting plate 83 are fitted onto the shaft 81 so as to be placed one upon the other.

The sealing member 82 is made of, for example, a rubber plate and curved so as to be upwardly convex as viewed in FIG. 9. The sealing member 82 has an outer circumferential edge closely adhered to the inner circumferential face of the conduit 74. The limiting plate 83 is made of, for example, a metal plate and curved

according to the sealing member 82. The limiting plate 83 limits an elastic deformation of the sealing member 82 in the direction opposed to the valve core 40, while allowing an elastic deformation of the sealing member 82 toward the valve core 40 side. Furthermore, the intermediate valve 80 is adapted to be direct moved in the passage 74 as described above and urged by a coil spring 84 toward the valve core 40 side.

The extended stem 34 has a release hole 73 formed in a distal end wall 34S thereof. When the release valve 65V is departed from the circular projection 70, compressed air passes through a gap defined between the release valve 65V and the inner circumferential face of the extended stem 34, released outside from the release hole 73.

In the valve unit 30W of the third embodiment, when air leaks at the valve core 40 side, pressure is increased at the valve core 40 side of the sealing member 82 of the intermediate valve 80. As a result, the intermediate valve 80 is moved to the side away from the valve core 40 against a spring force of the coil spring 84, and the sealing member 82 is deformed in the direction opposite the direction of its curvature thereby to be spread outward. Consequently, the outer edge of the sealing member 82 is closely adhered to the inner circumferential face of the stem 32, thereby preventing air in the tire 13 from leaking outside through the intermediate valve 80.

Furthermore, pressure is increased at the side opposite the valve core 40 in the sealing member 82 when the charge chamber 32B is charged with compressed air from the pump 12. In this case, the sealing member 82 is deformed such that the curvature

thereof is increased, whereupon a gap is defined between the inner circumferential face of the stem 32 and the sealing member 82. Consequently, air can be supplied through the gap into the tire 13. Furthermore, the intermediate valve 80 is moved to the valve core 40 side, so that the valve core 40 is pressed by the valve 80 to be opened. In other words, the intermediate valve 80 and the valve core 40 are linked with each other so as to be opened together, and accordingly, compressed air can readily be supplied into the tire 13.

In the valve unit 30W of the third embodiment, the valve core 40 and the intermediate valve 80 limit leakage of air from the tire 13 in association. When the internal pressure of the tire 13 is reduced, air can be supplied through the valve core 40 and the intermediate valve 80 into the tire 13.

FIG. 10 illustrates a valve unit 30X in a fourth embodiment of the invention. The fourth embodiment is a modified form of the third embodiment. In the stem 32X used in the valve unit 30X, a first space 86 encloses co-axially aligned valve core 40 and intermediate valve 80. The first space 86 serves as an air supply hole 72. The pipe 29 extending from the pump 12 is connected to a pipe joint 85 communicating with the air supply hole 72. The stem 32 has a second space 87 disposed in parallel with the first space 86. The release valve 65V is provided in the second space 87. Furthermore, the first space 86 has a chamber located nearer to the air supply hole 72 than the intermediate valve 80. The chamber communicates via a cave hole 88 with a chamber of the second space 87 which is located opposite the release hole 73 and defined by the release valve 65V. The same effect can

be achieved from the fourth embodiment as from the previous embodiments.

FIG. 11 illustrates a fifth embodiment of the invention. The fifth embodiment is a modified form of the fourth embodiment. The stem 32Y of the valve unit 30Y includes a second valve core 89 provided at the distal end side of the first space 86 extending coaxially with the valve core 40. The distal end of the stem 32Y serves as an external pump mount 100 in the invention. A cap 102 is attached to the pump mount 100 by thread engagement. The second valve core 89 has substantially the same basic construction as the valve core 40.

The air supply hole 72 is located between the second valve core 89 and the intermediate valve 80 and communicates with the first space 86. A pipe joint 101 is attached to the air supply hole 72 by thread engagement. The pipe 29 extending from the pump 12 is connected to the pipe joint 101.

According to the above-described valve unit 30Y, the same effect can be achieved from the fifth embodiment as from the first to third embodiments. Furthermore, when an external pump is connected to the pump mount 100, air can be supplied into the tire 13 by the external pump as occasion demands.

FIG. 12 illustrates a sixth embodiment of the invention. The sixth embodiment is also a modified form of the fourth embodiment. In the valve unit 30Z of the sixth embodiment, the release valve 65V of the valve unit 30X of the fourth embodiment is provided integrally with the outlet section 26 of the pump 12. More specifically, the cylindrical wall 27 of the outlet section 26 has an outlet 27A and a cave hole 27B in which the

release valve 65V is disposed.

When the release valve 65V is fixed to the pump 12 as described above, the release valve 65V can be disposed at the revolution center side of the wheel. Consequently, inertia (moment of inertia) due to the release valve 65V can be reduced as compared with a case where the release valve is provided on an outer edge of the wheel.

FIGS. 13 to 15 illustrate a seventh embodiment of the invention. The seventh embodiment differs from the first embodiment in the construction of the pump. The pump 12V used in the seventh embodiment employs a slider crank mechanism 20V to produce compressed air. More specifically, the rotary block 21V of the pump 12V includes a cylindrical member 90 and a cylinder 91 extending from a side wall of the cylindrical member. The cylindrical member 90 is disposed at the center of the wheel (see FIG. 1), and a plurality of hub spokes (see FIG. 1) fixed to the circumference of the cylindrical member 90.

A crank shaft 92 is provided in the cylindrical member 90. The crank shaft 92 has both ends unrotatably fixed to the bicycle body. A piston 93 is provided in the cylinder 91 so as to be direct moved. A link 94 is provided between the cylinder 91 and the crank shaft 92. The cylinder 91 has a distal end closed by a bottom wall 95. The outlet section 26V is provided in the bottom wall 95. The inlet section 25V is provided in a proximal end of the cylinder 91. A check valve 96 is provided on the side of the outlet section 26V opposed to the piston 93. The check valve 96 is pushed by compressed air from the cylinder 91 to be opened, whereas the check valve is closed when the pressure is

negative in the cylinder 91. The same effect can be achieved from the seventh embodiment as from the first to sixth embodiments.

The invention is applied to the bicycle 10 serving as the vehicle in the foregoing embodiments. However, the vehicle should not be limited to the bicycle. The invention may be applied to motorbikes, motorcycles, automobiles, air planes, carriages, etc. all of which are provided with pneumatic tires.

The valve core 40 is disposed at the outer edge side of the wheel 11 in the foregoing embodiments. However, the valve core 40 may be provided integrally on the pump 12, instead. Furthermore, the hub spokes 15 are fixed to the pump 12 in the foregoing embodiments. However, a fixing member for the hub spokes and the pump 12 may be adjacent to each other in the axial direction of the axle 22, instead. Additionally, the hub spokes 15 extend between the reel 14 and the central portion of the wheel 11 in the foregoing embodiments. However, a generally flat disc may be provided between the reel 14 and the central portion of the wheel 11, instead.

The foregoing description and drawings are merely illustrative of the principles of the present invention and are not to be construed in a limiting sense. Various changes and modifications will become apparent to those of ordinary skill in the art. All such changes and modifications are seen to fall within the scope of the invention as defined by the appended claims.